ITEA Journal 2009; 30: 288–294

Critical Directed Energy Test and Evaluation Infrastructure Shortfalls: Results of the Directed Energy Test and Evaluation Capability Tri-Service Study Update

Minh Vuong
U.S. Army Program Executive Office for Simulation, Training and Instrumentation, Orlando, Florida

Directed energy (DE) weapons are here. Groundbreaking work continues every day on high power microwaves and high energy lasers. These weapon systems offer several advantages over traditional weapons: speed-of-light delivery, deep magazines, graduated effects, and minimal collateral damage. DE weapon systems also offer new challenges including energy termination, energy reflections, electromagnetic interference, and many others. The United States cannot safely field DE weapon systems until sufficient developmental, operational, and live fire testing is complete. Current DE test and evaluation capabilities are fragmented, fixed, and not functionally integrated. The nation's DE test and evaluation infrastructure is insufficient to support current and next generation DE weapon systems.

Key words: Directed energy; infrastructure shortfalls; needs roadmap; Tri-Service Study (T-SS); weapons systems testing.

In 2002, the Directed Energy Test and Evaluation Capability (DETEC), a project with the goal to address a handful of directed energy (DE) test and evaluation (T&E) infrastructure needs, was proposed to the Office of the Secretary of Defense Central Test and Evaluation Investment Program (CTEIP). Before funding the effort, CTEIP commissioned a study to scope the magnitude of the problem. The purpose of the Tri-Service Study (T-SS) was to identify DE T&E needs, capabilities, shortfalls, and shortfall solutions.

The year 2003 marked the kickoff of the T-SS. Through a formal process, the T-SS identified and prioritized several critical shortfalls in the nation's ability to perform T&E on current and upcoming DE systems. Upon completion of the T-SS, CTEIP funded DETEC to resolve the highest priority shortfalls (grouped into capabilities) identified by the T-SS. The U.S. Army Program Executive Office for Simulation, Training, and Instrumentation administers the DETEC project, which to date has fielded 10 of 16 high priority capabilities. The DETEC project will provide the remaining nine capabilities by 2010.

In 2006, CTEIP and the Army Program Executive Office for Simulation, Training, and Instrumentation sought to update the T-SS results by repeating the formal process established in 2003, incorporating improvements from lessons learned. This T-SS Update identified 44 high priority shortfalls, grouped into 17 capabilities, which DE testers require within the next 12 years to provide the essential T&E of emerging DE weapon systems. CTEIP is planning to provide the necessary funding to DETEC to fill these critical shortfalls.

Previous shortfall solutions

The original T-SS identified 16 high priority capabilities required by DE testers, and the DETEC project is responsible for acquiring these capabilities. To date, DETEC has delivered 10 capabilities to the Major Range and Test Facility Base (MRTFB) to support DE testing. Several weapon programs have already utilized the fielded capabilities to support their testing efforts.

In August 2008, the U.S. Air Force Research Laboratory Optical Radiation Branch (AFRL/RHDO) utilized the DETEC-delivered High Energy Laser (HEL) Target Reflected Energy Measurement (TREM) capability to support testing of the Advanced Tactical Laser (ATL) at Kirtland Air Force Base. AFRL/RHDO and the ATL program will use the resulting HEL TREM information to obtain full-scale field test data to validate ATL collateral effects models, to validate AFRL/RHDO eye safety analysis models,

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2009		**00-00-2009 to 00-00-2009**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Critical Directed Energy Test and Evaluation Infrastructure Shortfalls: Results of the Directed Energy Test and Evaluation Capability Tri-Service Study Update	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **U.S. Army Program Executive Office for Simulation, Training and Instrumentation,12350 Research Parkway,Orlando,FL,32826-3276**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**7**	

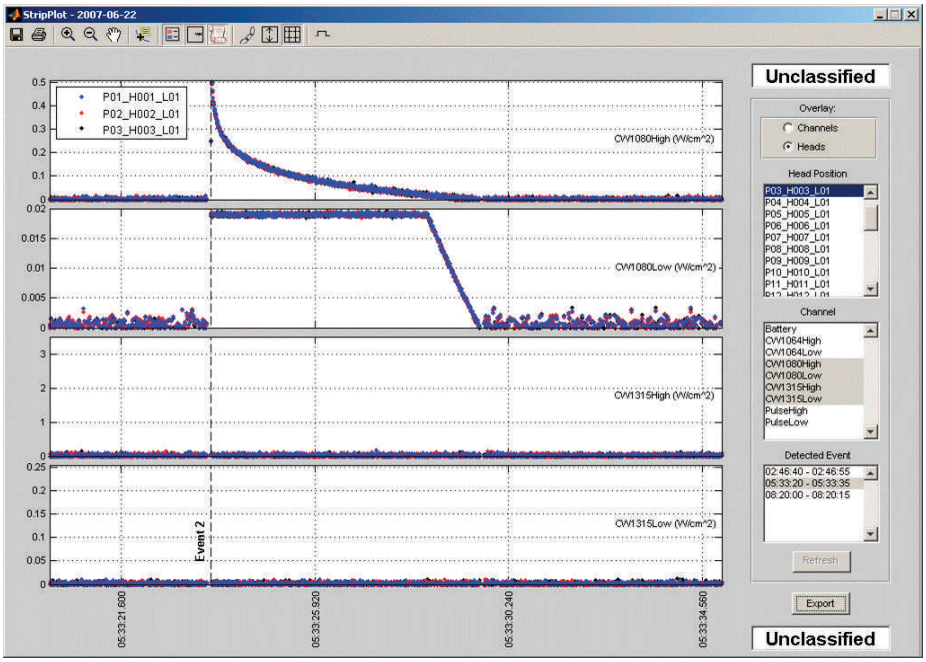

Figure 1. Measurement of energy reflected from a target by High Energy Laser Target Reflected Energy Measurement, capability.

and to establish a finite set of collateral hazard zones for ATL and future systems. AFRL/RHDO will also utilize the HEL TREM capability in support of testing at the Naval Surface Warfare Center in Dahlgren, Virginia. *Figure 1* depicts an example of output for three HEL TREM units used during a test. The x axis shows time, and the y axis shows the detected reflected irradiance (i.e., watts per square centimeter). The two top graphs show the processed data for the 1,080-nanometer wavelength sensor tube for high and low dynamic range of detected irradiance. The lower two graphs are for the 1,315-nanometer wavelength sensor tube, which was not utilized for this test.

In October 2008, ATL used the DETEC-delivered HEL Ground Target Irradiance Measurement (GTIM) capability to support testing at Kirtland Air Force Base. The ATL program will utilize the HEL GTIM measurements to diagnose beam power on target. After the successful ground testing, ATL used the HEL GTIM to support flight testing at White Sands Missile Range in late 2008. *Figure 2* shows an example of the HEL GTIM quick look output. In addition to the quick look information, data files are generated that permit in-depth, quantitative, post-test analyses of the beam irradiance profile.

In September 2007, White Sands Test Center (WSTC) utilized the DETEC-delivered High Power Microwave (HPM) Test Hazard Prediction (THP) capability to perform a quick-turnaround, high-priority hazard prediction to determine whether HPM transmitters at a proposed new test site would pose any potential hazards to two other existing sites at the range. The resulting hazard prediction concluded that with the antennas pointed in their intended directions, the hazard footprints do not extend near either of the two sites of interest and permitted WSTC to continue with their site development plans.

In 2008, WSTC used the DETEC-delivered HPM Sensor Suite system to support Counter-Improvised Explosive Device (C-IED) testing at White Sands

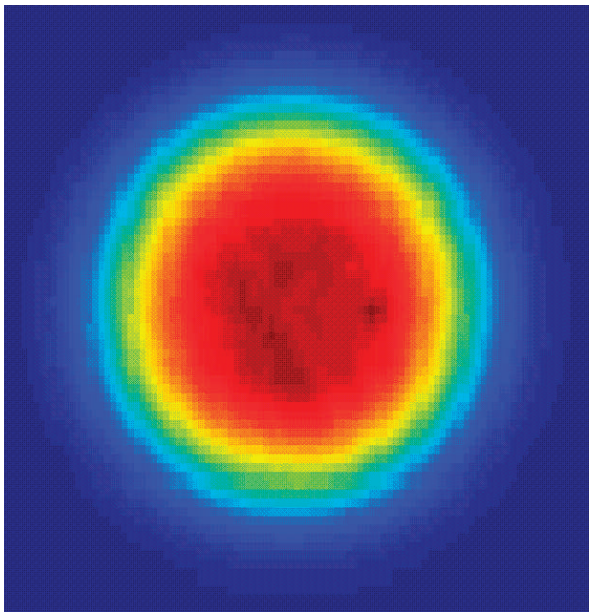

Figure 2. Laser spot as imaged by High Energy Laser Ground Target Irradiance Measurement, capability.

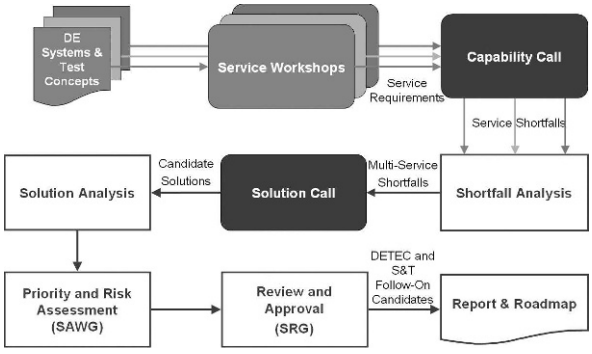

Figure 3. Tri-Service Study Update process.

Missile Range. WSTC also used the HPM Sensor Suite to help characterize a new facility, the Electromagnetic Radiation Effects facility. Use of the HPM Sensor Suite capability was also used to support testing of another DETEC capability, the HPM Narrowband Threat System in late 2008.

T-SS Update Process

The original 2003 T-SS established a formal process to produce a roadmap of critical DE T&E infrastructure shortfalls and the resources required to address them. The T-SS Update used this same process, shown in *Figure 3*. Beginning with existing DE systems and system concepts from each service, the T-SS Update used a joint approach to vet and approve T&E requirements for the next 12 years. The T-SS Update also queried the MRTFB for their existing T&E capabilities. The gap between identified needs and current capabilities constitutes shortfalls. The T-SS Update process also requested information from government, industry, and academia about potential solutions to these shortfalls. Utilizing the provided priority of each shortfall and the technical risk of any potential solutions, the Solution Analysis Working Group (SAWG) prioritized all of the submitted shortfalls. After approval by the Senior Review Group, the T-SS Update documented these shortfalls in a final report and set of roadmaps. The following paragraphs describe the process in detail.

The T-SS Update began by identifying current DE systems and concepts that could require testing within the next 12 years. The 12-year horizon ensures the shortfalls identified by the T-SS Update are valid and rooted in current and emerging DE weapon systems. The U.S. Army, Navy, and Air Force each supplied several systems and concepts. *Table 1* shows each system or concept, its type (i.e., HEL or HPM), and its mission.

To finalize the testing requirements for these systems and concepts, the T-SS Update team hosted three workshops: one each for the Army, Navy, and Air Force. In each workshop, personnel reviewed their service's systems/concepts requiring tests, how they would be tested, and what capabilities were required to complete the tests. In addition to the systems and concepts in *Table 1*, each workshop considered threat systems and concepts capable of producing the electromagnetic effects described in the upcoming revision to Military Standard 464 (MIL-STD-464) Electromagnetic Environmental Effects Requirements for Systems. The outcome of the workshops was capturing T&E requirements for current and upcoming DE systems during the next 12 years.

After establishing the T&E requirements, the T-SS Update team next identified what test capabilities currently existed. A capability call was sent to the members of the MRTFB. The respondents were asked to identify their test capabilities directly related to the identified requirements. By performing a cross matrix analysis of the joint requirements with the MRTFB's existing capabilities, the T-SS Update team identified the joint shortfalls in DE test infrastructure. The result was 52 joint shortfalls: 16 HEL and 36 HPM.

After finalizing the shortfalls, the T-SS Update team issued a call for solutions to the shortfalls. The purpose of the solution request was to gauge the resources required to fill the shortfalls. White paper responses were received for 12 shortfalls.

The SAWG, with representation from all three Services, reviewed each of the shortfalls and submitted white papers and ranked them based on priority and technical risk. The SAWG concluded that several of the shortfalls could be addressed by a single T&E capability. Where advantageous, the SAWG grouped shortfalls, resulting in the identification of 17 capabilities to address the 52 shortfalls (i.e., 44 high priority shortfalls, three low priority shortfalls, and five science and technology shortfalls). The T-SS Senior Review Group approved the SAWG recommendations for the grouped shortfalls.

The final step in the T-SS Update process was to produce roadmaps based upon the results of the study. Four roadmaps were produced: (1) HEL Joint, (2) HEL Service Unique, (3) HPM Joint, and (4) HPM Service Unique. Each roadmap contains traceability of the shortfalls to the related shortfall approach information, the requirements it addresses, and the DE systems/concepts that have the requirement. The DETEC development team will utilize these roadmaps to continue to fill T&E infrastructure shortfalls.

Shortfalls

The T-SS Update process identified 52 shortfalls, 44 of them high priority. These shortfalls were grouped where synergies or combinations of shortfalls

Table 1. Detected energy (DE) systems submitted by the Services.

System/concept	Type	Mission
		Air Force Systems
Aircraft Self-Protection (ASP)	HEL	Bomber self-protection; Surface-to-Air Missile (SAM), Air-to-Air Missile (AAM), Man-Portable Air-Defense Systems (MANPADS), fighters
Advanced Tactical Laser (ATL)	HEL	Airborne precision strike of ground targets, hostage rescue scenarios
Airborne Laser (ABL)	HEL	Theater Ballistic Missile (TBM) defense
Ground-Based Laser with Relay Mirror (GBL RM)	HEL	Airbase defense
Active Denial System (ADS)—Airborne	HPM	Nonlethal crowd control
Airborne Electronic Attack (AEA)	HPM	Infrastructure attack (supervisory control and data acquisition)
AEA	HPM	Tactical military targets (Improvised Explosive Devices (IED), landmines, forward-looking infrared)
Enhanced Precision Guided Munitions (EPGM)	HPM	Military and infrastructure targets
HPM Airbase Defense System (HADS)	HPM	Rocket Artillery Mortar (RAM), Precision Guided Munitions (PGM)
HADS	HPM	Aircraft
HADS	HPM	Protection of aircraft departing, arriving, and orbiting airbases from man portable ground to air missiles
		Army Systems
Joint DE Maneuver Support System (JDEMSS)	HEL	Standoff mine neutralization and unexploded ordnance
Joint multimission DE Protection System (JMDEPS)	HEL	Detect, track, engage, and destroy rockets, artillery, and mortar threats and meet other evolving Army mission needs
JMDEPS	HEL	Antitank Guided Missile (ATGM)/Rocket Propelled Grenade (RPG)
Joint Multimission DE Strike System	HEL	Area denial to aircraft, unmanned air vehicles (UAV), helicopters, and other light aircraft
ADS	HPM	Nonlethal crowd control
ADS–Vehicle	HPM	Stops ground vehicles at standoff range without harm to occupants
Counter-IED	HPM	Neutralize improvised or designed explosive devices intended to impede progress of maneuver elements.
Counter-Mine	HPM	Surface and buried landmines
SPARROW	HPM	The mission of SPARROW is to protect high value facilities from penetration and damage by individuals carrying or wearing bombs. IED Vests and packages.
		Navy Systems
ASP	HEL	Protection of aircraft from anti-aircraft threats
ATL	HEL	Short-range airborne protection of naval assets against above-water threats, carrier or land-based
Ship-Based Area-Defense Laser (SBADL)	HEL	Medium-range ship protection; Anti-Ship Cruise Missile (ASCM), TBM
Ship-Based Self-Defense Laser (SBSDL)	HEL	Short-range ship self-protection; ASCM
ADS–Ship	HPM	Nonlethal crowd control
AEA	HPM	Military and infrastructure
AEA	HPM	Anti-electronics against ship and littoral targets
EPGM	HPM	Air delivery, limited ground, and maritime environments

HPM, high power microwave; HEL, high energy laser.

that leveraged each other existed. The result was the 17 high priority capabilities shown in *Table 2*. Twelve of the capabilities address HPM T&E infrastructure shortfalls. The remaining five capabilities address HEL T&E infrastructure shortfalls. The following paragraphs provide short descriptions of the 17 identified capabilities (H1–H17).

H1—HPM sensor suite #2 for testing blue systems

The first high priority capability, H1, addresses the need for a suite of HPM sensors to measure a variety of parameters, including continuous wave (CW) narrowband, pulsed narrowband, and pulsed wideband. These measurements will enable the monitoring of HPM source output and inside target measurements for wideband (e.g., inside a missile). This capability is a combination of four high priority shortfalls identified by the T-SS Update process. The original T-SS in 2003 also identified H1 as a high priority. As a result, the DETEC project built the first sensor suite; however, the demand for this T&E capability is so great that a second is required.

H2—HPM sensor array for C-IED testing

Another high priority capability, H2, is the need to measure the HPM field patterns laid out across a wide area to support C-IED testing. The sensor array must

Table 2. Seventeen high priority capabilities identified in Tri-Service Study Update.

Capability	DE type	Title
H1	HPM	Sensor Suite #2 for Testing Blue Systems
H2	HPM	Sensor Array for C-IED Testing
H3	HPM	Ground Target Sensors
H4	HPM	Measure at Point Inside Target, Near Chip
H5	HPM	Human Instrumentation for ADS
H6	HPM	M&S Working Group
H7	HEL	CW SSL Lethality Testing
H8	HEL	CW Irradiance Profile
H9	HPM	Overhead Illumination
H10	HPM	Non-Intrusive Sensor
H11	HPM	Chamber Test Capability—Explosive Equivalent Substitute
H12	HEL	Irradiance & Temperature
H13	HEL	Near/In-Beam Path Quality
H14	HPM	Sensor Net
H15	HPM	Sensor Suite #3 for Blue on Red Testing
H16	HPM	CW Narrowband Sensors in Target
H17	HEL	Imagery of Airborne Targets

DE, directed energy; HPM, high power microwave; HEL, high energy laser; C-IED, counter-improvised explosive device; ADS, Active Denial System; M&S, modeling and simulation; CW, continuous wave; SSL, solid state laser.

be capable of measuring signals produced by mobile HPM C-IED platforms. Signals will be used to help determine fratricide issues as well as to assess blue system capability. The sensor array should be able to measure the fields on, or near, the ground as the C-IED system first enters the target zone, drives through, and then leaves. After the drive through, testers should be able to have immediate access to the field data as a function of time. A large number of sensor nodes will be required to properly map the field pattern. Sensor nodes, therefore, should be networked, self-healing, hardened against the incident radiation, and inexpensive.

H3—HPM ground target sensors

H3 is the high priority need for a capability to measure narrowband and wideband width fields close to the ground. The capability will support both C-IED and counter-mine measurements. For narrowband, it supports both CW and pulsed HPM system test activities. In and around a ground surface, the E- and H-fields (electrical and magnetic, respectively) may not be perpendicular and the principle beam direction may not be traceable back to the source. The proximity of the ground can also cause interactions with the sensor and, in the worst case, the sensor with the target. The requirement also addresses the need to develop nonintrusive narrowband and wideband sensors capable of recording these fields. This capability is a synergy of three high priority shortfalls identified by the T-SS Update.

H4—HPM measure at point inside target, near chip

H4 addresses the need for a capability to measure, or calculate from other measurements, the energy at a point inside the target. Presumably, this point is at the target chip or board and the capability will not intrude on the measurement by more than 5 percent.

H5—HPM human instrumentation for the Active Denial System

The fifth high priority capability, H5, is the need for a capability to remotely measure the human response to exposure of wideband HPM energy in support of the Active Denial System and similar systems. The capability should enable the remote monitoring of individual response within a group engagement; it will be used to support group response modeling that can be applied to multiple engagement scenarios.

H6—Modeling and simulation working group

H6 addresses the need for a DE modeling and simulation focus group. This group would identify existing modeling and simulation capabilities and work with the DE T&E community to establish a common set of tools. The group would also work with the community to develop common test and data collection standards. Finally, the group would work to identify data repository solutions for the community. This capability is a combination of five high priority shortfalls identified by the T-SS Update.

H7—HEL CW solid state laser lethality testing

H7 is the high priority need for a CW solid state laser capable of conducting lethality testing. The laser would be a surrogate for solid state CW laser weapon systems under development and used to conduct lethality/target effects testing in support of system requirements development/validation. The key shortfall is that no adequate CW laser currently exists to support lethality testing for developing solid state CW HEL systems.

H8—HEL CW irradiance profile

H8 is the need for a capability to measure the time-dependent spatial profile/distribution of laser irradiance both near the laser aperture and incident on a target (data must be time stamped). The measurements would support ground testing against targets such as missiles, artillery shells, unmanned aerial vehicles (UAVs), etc. The key shortfall is that the measurements are needed to determine irradiance exiting the aperture and on the actual target (i.e., not a nontactical diagnostic target) independent of target properties (e.g., type, shape, physical properties) or target motion,

including spinning, while not affecting the total power transmitted to the target by more than 5 percent. This is required to allow noninterference of the measurement with lethality testing results. The measurement can use either onboard (on the target) or offboard sensors; however, onboard sensors must not significantly affect the target dynamics or response to laser irradiation (e.g., surface absorptivity, structural response). This capability is a combination of two high priority shortfalls identified by the T-SS Update.

H9—HPM overhead illumination

H9 is the high priority capability to operate red threat surrogates to irradiate the system under test from overhead, thereby simulating an air to ground attack. This capability is required for both narrowband and wideband threat systems. Although the HPM Narrowband Threat System and HPM Wide Band Threat System capabilities currently under development by DETEC meet threat requirements, they cannot be elevated above the target and shoot down. The HPM Narrowband Threat System can be tilted ±5 degrees, whereas the HPM Wide Band Threat System can be tilted ±10 degrees. This capability is a combination of three shortfalls identified by the T-SS Update.

H10—HPM nonintrusive sensor

H10 addresses the need for a capability to measure electric and magnetic fields without intrusion. Specific applications include the measurement of the near-field environment, where history of the field directions is important along with the measurement of fields inside targets. The sensors would be capable of measuring pulsed narrowband and wideband microwaves. For sensors installed in targets, the targets may be on the surface, in the air, or at sea. Some sources may be in such things as artillery shells or UAVs and may impact the earth. Possible targets include missiles in flight or a relatively close command, control, and communications target. Capability is also required to recover the measured data after the event for post-analysis. This capability is a synergy of four high priority shortfalls identified by the T-SS Update.

H11—HPM chamber test capability–explosive equivalent substitute

H11 is the need for a capability to support various small targets for lethality testing that normally contain explosives or other hazardous materials. The environment for these targets should be as close to an operational environment as possible in a chamber. Supporting infrastructure for these targets should be constructed to minimize interference with the beam to the greatest extent possible. This capability requires that explosives or other hazardous materials contained in the target be removed and replaced with suitable materials that replicate the radio frequency characteristics of the removed material. This differs from the current DETEC HPM Target Surrogate Materials capability by addressing the shortfall of additional frequencies from 6–10 GHz.

H12—HEL irradiance and temperature

H12 addresses the shortfall of a capability to measure the laser irradiance incident on, and surface temperature of, ground and airborne targets. The measurements would be spatially resolved and time stamped and support outdoor, live-fire testing against dynamic airborne targets such as short-range missiles, artillery shells, UAVs, etc. This measurement would also not affect the power transmitted to the target by more than 5 percent to enable non-interference with lethality testing results. The measurement can use either onboard or offboard sensors; however, onboard sensors must not significantly affect the target dynamics or response to laser irradiation (e.g., surface absorptivity, structural response). This capability is a synergy of four high priority shortfalls identified by the T-SS Update.

H13—HEL near/in-beam path quality

H13 is the need for a capability to make atmospheric optical turbulence, atmospheric aerosol constituent, and laser transmissivity measurements along the laser beam path. The measurements would support outdoor, live-fire testing against both static and dynamic targets. This capability is a synergy of three high priority shortfalls identified by the T-SS Update.

H14—HPM sensor net

H14 is the need for a capability to test unintended effects for blue HPM weapons on close civilian infrastructure (e.g., hospitals, emergency services, telephone exchanges). The capability is also required to test effects for red weapons on both military and civilian infrastructure facilities and equipment. Military infrastructure includes control towers, communication centers, power distribution centers, administrative processing centers, and installation security systems. The electronic devices must be installed, maintained, and operated for testing purposes. This specific capability requirement is to be able to monitor, diagnose, and assess the radio frequency inside facilities that results in observed effects on the selected unintended civilian targets. Here, facilities may be a single representative target such as a hospital, or a number of representative buildings found in an urban

environment. This capability is a combination of two high priority shortfalls identified by the T-SS Update.

H15—HPM sensor suite #3 for blue on red testing

H15 is the need for a suite of HPM sensors to measure a variety of parameters including CW narrowband, pulsed narrowband, and pulsed wideband. These measurements will enable the monitoring of HPM source output and inside target measurements for wideband (e.g., inside a missile). This high priority capability addresses the combination of four shortfalls identified by the T-SS Update.

H16—HPM CW narrowband sensors in target

H16 addresses the requirement for a capability to measure a variety of HPM CW narrowband parameters inside a HPM target, including targets with a water background. It is necessary not to affect the interaction of HPM energy with the target while measuring the stated parameter where interference is defined as having less than a 5 percent effect on the value measured. The beam may have a frequency from 400 MHz to 10 GHz and intensity commensurate with HPM power at a target such as a missile in flight. The target may be in a ground facility or open air range at the time of measurement. This specific capability is for the sensor placed at the target location and cabling, or other connectivity, to an existing data acquisition system such as the HPM Sensor Suite. This capability is a synergy of three high priority shortfalls identified by the T-SS Update.

H17—HEL imagery of airborne targets

H17 is the requirement for a capability to measure the imagery of an airborne target being irradiated by a CW laser beam (data must be time stamped). The measurement would support outdoor, live-fire testing against dynamic airborne targets, such as short-range missiles, artillery shells, UAVs, etc. The imagery would be for several spectral bands, including the same spectral band as the laser (i.e., in-band) and would be spatially resolved. The key shortfall is that the imagery spatial resolution must be improved for live dynamic targets at the target altitudes of interest.

Conclusions

The current DETEC project delivered numerous capabilities already in use by the DE T&E community and is scheduled to deliver several more in 2009. Through this current CTEIP project and the T-SS Update process, CTEIP is executing a comprehensive roadmap reflecting the DE T&E needs of the Department of Defense and assessing the adequacy of the MRTFB to provide testing in concert with the development and fielding of DE weapon systems. The established process leverages Service investments and enables joint developments that will maximize efficient inter-Service use of DE T&E assets.

The recent DETEC T-SS Update provided an updated roadmap of future DE T&E requirements, capabilities, shortfalls, and the resulting shortfall solution approach. The study grouped the current shortfalls into 17 high priority capabilities that are being considered by CTEIP for future funding. CTEIP plans to repeat the T-SS process periodically to ensure that the most current DE T&E needs are captured and addressed. The updates will be utilized to make funding decisions regarding the acquisition of future capabilities to address emerging shortfalls. ❑

Mr. Minh Vuong is a senior project director in the Program Manager Instrumentation, Targets, and Threat Simulators (PM-ITTS) at the U.S. Army Program Executive Office for Simulation, Training and Instrumentation (PEO STRI). He received a bachelor of science degree in electrical and computer engineering from George Mason University in Fairfax, Virginia, in 1991 and a master of business administration degree from Webster's University in 2001. In addition to being the project director for the Directed Energy Test and Evaluation Capability (DETEC), he also serves as the executing agent for the Directed Energy Test Science and Technology (DET S&T) Focus Area. Mr. Vuong has managed several major test and evaluation instrumentation projects for the Army and the Office of the Secretary of Defense (OSD) Central Test and Evaluation Investment Program (CTEIP). E-mail: Minh.Vuong@us.army.mil